
ENHANCING AGRICULTURAL PROGRESS VIA SUSTAINABLE PRODUCTION AND CONSUMPTION

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ABSTRACT

The paper's main aim is to discuss the importance of reducing environmental impact, conserving biodiversity, and addressing socio-economic concerns within the context of agriculture. The research methodology involves a comprehensive review of existing literature, and data analysis to address the following research questions: By emphasizing the interdependence of ecological, social, and economic factors, the paper provides insights into holistic approaches to sustainable agriculture. The paper contributes to the field by offering practical recommendations and policy implications for policymakers, practitioners, and stakeholders involved in agriculture. It highlights the importance of collaborative efforts among various stakeholders to foster innovation, promote knowledge sharing, and drive systemic change towards a more sustainable food system. Through its interdisciplinary approach, the paper bridges gaps in understanding and offers pathways for achieving agricultural progress while safeguarding the environment and ensuring food security for future generations.

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Introduction

In both academic and public discourse concerning global development, the pursuit of sustainable agricultural practices is regarded as a fundamental imperative. The nexus between sustainable production and consumption in agriculture not only fosters environmental resilience, thereby further boosting socio-economic progress (Polcyn, 2023). Based on the United Nations Sustainable Development Goals (SDG), particularly SDG 12 (Responsible Consumption and Production) (2015), this paradigm emphasizes the necessity to harmonize agricultural activities with ecological integrity and social equity. In the context of the European Union (EU), a highly influential advocate of sustainable development agendas, concerted efforts have been made to redefine agricultural practices in alignment with sustainability imperatives. Romania, as one of the EU's agrarian constituents (Feher, 2020), provides an illustrative case study in which the interplay of policy frameworks, socio-economic dynamics, and environmental exigencies influences the trajectory of agricultural sustainability. The evolution of the agricultural sector has resulted in substantial changes to inputs and investments, along with unprecedented shifts in trend evolution, which have collectively led to significant alterations in agricultural patterns, as previously asserted by Andrei et al. (2022).

This article aims to enhance understanding of the multifaceted dimensions of enhancing agricultural progress via sustainable production and consumption, with a specific focus on the EU context and the intricate landscape of Romanian agriculture. Sustainable agriculture seeks to address the challenges of food security, environmental degradation, and socio-economic disparities. At its core lies the principle of ensuring the longevity of agricultural systems by minimizing negative environmental impacts, optimizing resource utilization, and enhancing resilience to external shocks (Leoveanu-Soare, 2020). SDG 12 represents the global commitment towards fostering sustainable patterns of consumption and production, with a particular emphasis on the agricultural sector. By promoting resource efficiency, reducing food waste, and fostering equitable access to land and resources, SDG 12 underscores the pivotal role of agriculture in achieving broader sustainability objectives (Frone & Frone, 2020). The radical transformation of national agricultural systems influenced by the convergence with European agricultural standards and directives, as argued by Dragoi et al. (2016), results in substantial changes in the agri-food markets, impacting the structure and dynamics of food trade and, consequently, affecting food safety.

Within the EU framework, sustainable agriculture has emerged as a cornerstone of the European Green Deal, a comprehensive policy agenda aimed at transitioning towards a carbon-neutral, circular economy. The Farm to Fork Strategy (2020), a flagship initiative under the European Green Deal, outlines ambitious targets for reducing greenhouse gas emissions, promoting organic farming, and enhancing biodiversity conservation within the agricultural sector. Through regulatory measures, financial incentives, and knowledge-sharing initiatives, the EU seeks to empower farmers and stakeholders to embrace sustainable practices while ensuring the resilience and competitiveness of European agriculture on the global stage. The forthcoming section presents a detailed

examination of the existing body of literature, followed by an in-depth analysis of Sustainable Development Goal 12 (SDG 12) as it pertains to Romania, utilizing data sourced from Eurostat (2024). The section culminates with conclusions that synthesize the findings and insights discussed.

The aim of this paper is to examine the various aspects of enhancing agricultural development through sustainable production and consumption. Specific focus will be given to the EU context and the complex agricultural environment of Romania. One of the primary objectives of this study is to examine the current state of sustainable farming practices in Romania in the context of SDG 12. Additionally, the study utilizes data from Eurostat to evaluate Romania's performance in critical sustainability metrics. Furthermore, it aims to offer constructive recommendations to stakeholders, practitioners, and policymakers to enhance sustainable agricultural practices. Lastly, it highlights the agricultural sector's potential for supply chain management and sustainable intensification in Romania.

Literature Review

Mouratiadou (2021) defines sustainable intensification (SI) as a means of increasing agricultural productivity while simultaneously reducing negative environmental impacts, a concept that has gained considerable traction in the literature and among policymakers. The concept of sustainable intensification (SI) encompasses a variety of strategies, including the optimisation of input utilization, the adoption of advanced technologies and the enhancement of crop management practices. As Smith et al. (2020) state, the integration of sustainable production and consumption practices in agriculture has two main objectives: firstly, to increase productivity and secondly, to minimize environmental impacts. Beltran-Peña et al. (2020) argue that the dual emphasis on productivity and sustainability is what has attracted global attention to SI. In the view of MacLaren et al. (2022), the key components of SI include enhancing resource use efficiency, improving soil health, and reducing reliance on synthetic inputs. It is crucial to recognise that successful implementation of SI requires context-specific solutions that are tailored to the specific local conditions and needs.

Sustainable supply chain management (SSCM)(Nayal et al., 2021) in agriculture involves optimizing the entire food production process, from farm to table. SSCM practices include reducing waste, enhancing resource efficiency, and maintaining ethical standards throughout the supply chain. Sharma et al. (2021) highlight that integrating sustainability into supply chain operations is driven by consumer demand and regulatory pressures.

In the context of Romania, the pursuit of Sustainable Development Goal (SDG) 12 - Responsible Consumption and Production, within the agricultural sector, is paramount for achieving broader sustainability objectives (Government of Romania, 2020). The alignment of Romania's agricultural practices with SDG 12 embodies a commitment to enhancing resource efficiency, reducing environmental degradation,

and fostering equitable access to agricultural resources (Firoiu et al., 2019). The legacy of centralized planning, land fragmentation, and limited access to modern technologies has historically hindered the transition towards sustainable agricultural production and consumption patterns. However, recent policy initiatives and strategic interventions have sought to address these challenges and align Romania's agricultural sector with the principles outlined in SDG 12. Mensah et al. (2023) contend that current targets set out in the Sustainable Development Goal 12 (SDG12) for monitoring sustainable food consumption are inadequate and argued that more robust policy indicators and a comprehensive definition of sustainable food consumption are required. Tseng et al. (2016) highlight that SCP in emerging markets involves novel methods, practices, and opportunities to address environmental issues through various approaches, including firms, supply chain networks, and government regulations. This is evident in the growth patterns of countries with varying economic statuses, reflecting diverse strategies and innovations tailored to their specific contexts.

As Tukker et al. (2010) argue, sustainable consumption and production (SCP) refer to a global effort to improve living conditions without exhausting resources or damaging biogeochemical systems. This concept aligns closely with the trends observed in the EGGs, where the increasing GVA indicates a shift towards more sustainable economic activities. Furthermore, Singh and Singh (2017) suggest that traditional agriculture is a climate-smart approach for sustainable food production, addressing environmental problems like climate change and increasing population. The National Strategy for Sustainable Development (NSSD) serves as a foundational framework for integrating sustainability principles into Romania's agricultural policies and practices (Government of Romania, 2020). Encompassing diverse sectors, including agriculture, the NSSD emphasizes the importance of promoting resource efficiency, reducing waste, and enhancing the resilience of agricultural systems to climate change impacts. By incorporating SDG 12 targets into its strategic vision, Romania demonstrates a commitment to fostering responsible consumption and production patterns within its agricultural sector. Moreover, Romania's National Rural Development Program (NRDP), supported by EU funding, plays a pivotal role in promoting sustainable agricultural practices across rural communities (Ministry of Agriculture and Rural Development, 2014). Through targeted investments in infrastructure, technology transfer, and capacity-building initiatives, the NRDP seeks to enhance the competitiveness and sustainability of Romania's agricultural sector while advancing SDG 12 objectives. By fostering the adoption of agroecological practices, organic farming methods, and efficient resource management techniques, the NRDP contributes to reducing environmental footprints and promoting responsible consumption patterns among farmers and stakeholders.

Despite significant progress, several challenges hinder the widespread adoption of sustainable agricultural practices. These include limited access to financial resources, lack of supportive policies, and inadequate infrastructure. Addressing these barriers requires providing financial incentives, investing in research and development, and developing policies that support sustainable agriculture. Additionally, enhancing farmer education

and community involvement is crucial in promoting sustainable practices (Pe'er et al., 2020). As Dragoi (2016) notes, the limitations of the traditional linear economic system have prompted the development of new, contemporary economic models, which are frequently hybrids in nature and have played a significant role in transforming conventional production and consumption relationships. Future research should focus on refining the definitions and metrics of sustainable intensification, exploring regional variations, and developing comprehensive models that integrate economic, environmental, and social dimensions of sustainability. The integration of digital technologies and data analytics in agriculture, known as digital agriculture, presents promising opportunities for optimizing resource use and improving decision-making processes (Tian et al., 2021).

Data and Methods

The analysis of sustainable production and consumption is based on an investigation of the relevant indicators, namely the circular material use rate (CMR), the raw material consumption (RMC) and the gross value added (GVA) by the environmental goods and services sector (EGSS) available in Eurostat, (2024). The data set covers the period from 2019 to 2022 and is analyzed both for the EU as a whole and for individual member states from 2019 to 2022. The data were visualized and analyzed with the objective of identifying trends, comparing performances and highlighting significant changes in raw material consumption over the specified period. The countries are also analyzed in terms of their absolute volumes and trends over the specified period.

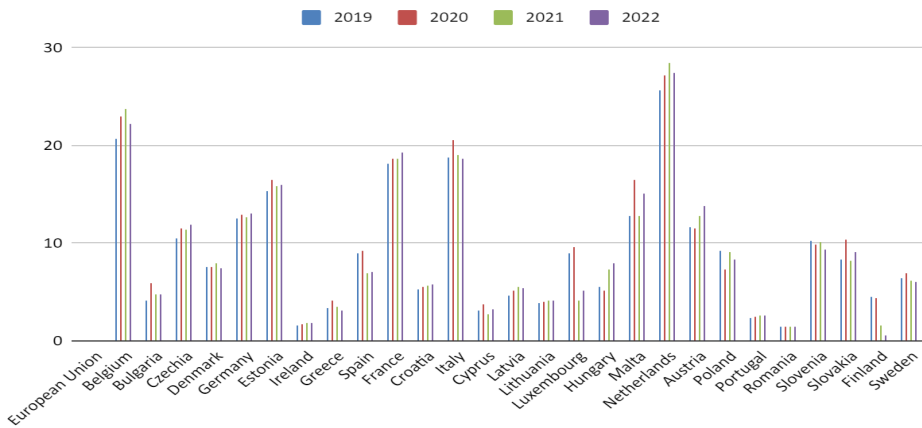
Analysis of SDG-12 in Romania and European Union

This section conducts a comprehensive analysis of the European Union Eurostat data to evaluate whether Romania is adhering to the criteria established under Sustainable Development Goal 12 (SDG 12). This evaluation involves a thorough examination of three indicators provided by Eurostat, which are essential in assessing Romania's progress towards sustainable consumption and production patterns. Through this analysis, the section aims to determine the extent of Romania's alignment with the SDG 12 targets and identify areas requiring further improvement. Firstly, the circular material use rate (see Fig. 1) is an important indicator of how efficiently a country is using its materials. It measures the proportion of material consumption that is recycled and reused in the production cycle rather than being wasted. A higher CMR means that more waste is being converted back into usable materials, reducing the need for new raw materials and lessening the environmental impact. Romania's results are relatively low compared to other countries, indicating a lower CMR. This suggests that a smaller share of material recovered is fed back into Romania's economy relative to its overall material use. The figure indicates that the EU average is higher than that of Romania. This means that on average, EU countries recycle and reuse a larger proportion of their waste materials compared to Romania. Since Romania's CMR is lower, it implies that the country relies more heavily on primary raw materials, which typically involve higher environmental costs due to extraction, processing, and transportation.

Moreover, a lower CMR can also have economic implications, as it might mean that Romania is not fully capitalizing on potential savings from using secondary materials. The information could be used by policymakers in Romania to identify opportunities for improving waste management systems, encouraging recycling, and supporting the circular economy through incentives for using recycled materials in production.

The figure shows that Romania has significant room for improvement in increasing its CMR. Efforts to enhance the recycling infrastructure, waste management policies, and incentives for using recycled materials could potentially increase Romania’s CMR, bringing both environmental and economic benefits. Additionally, keeping track of trends over time would be critical to evaluate the effectiveness of any measures taken to improve the CMR.

Figure 1. Circular material use rate in EU



Source: Eurostat, 2024

The first figure highlights a discernible pattern of slight fluctuations in the CMU rate for the EU from 2019 to 2022. This indicates that there is a relatively stable trend in the rate, which does not undergo significant upward or downward shifts. This stability suggests the existence of established practices in recycling and the reuse of materials throughout the Union. The analysis of the rates of recycling and reuse across the EU reveals a mixed picture of progress and challenges. Those countries which perform well, such as the Netherlands and Belgium, can be regarded as exemplars, demonstrating effective strategies which other countries might wish to emulate. The substantial enhancements observed in Italy and Estonia illustrates that targeted policies and investments in infrastructure can yield favorable outcomes. Nevertheless, the poor performance of countries such as Romania and Bulgaria highlights the necessity for bespoke strategies that address the specific obstacles to the adoption of a circular economy.

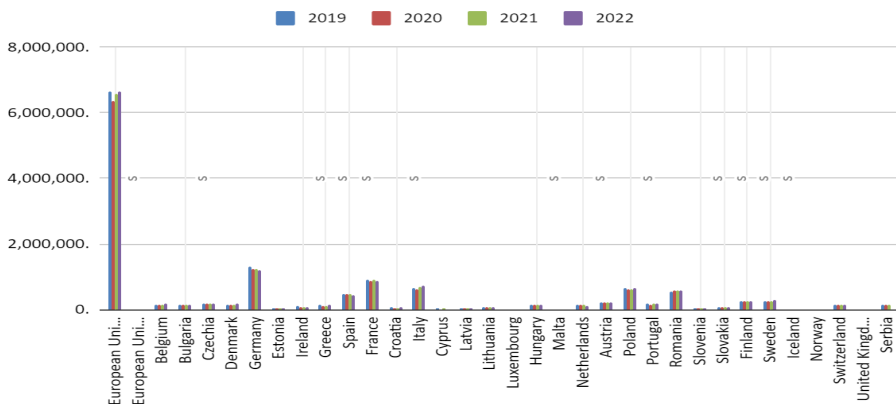
The Netherlands records the highest CMU rate among EU countries on a consistent basis, which demonstrates a strong commitment to the principles of a circular economy. Furthermore, Belgium also merits mention as a high-performing country, having consistently maintained a robust CMU rate over time. The relatively high CMU rates

observed in Luxembourg and France reflect the effectiveness of their recycling and material reuse strategies. Italy and Estonia have demonstrated significant improvements in their CMU rates.

The notable increase observed in Italy between 2019 and 2022 suggests an enhancement in circular economy practices, which is likely driven by improved policies and infrastructure. Estonia has displayed a rising trend, particularly evident in 2022, indicating an increasing effectiveness in recycling and material reuse. Germany, Spain, and France have demonstrated a relatively stable CMU rate with slight fluctuations, reflecting a consistent implementation of circular economy practices and a robust recycling culture. In contrast, Romania and Bulgaria have the lowest CMU rates among EU countries, indicating a limited capacity for recycling and material reuse. Portugal and Finland also exhibit lower CMU rates in comparison to the EU average, highlighting an urgent need for strengthened circular economy policies and practices.

Analyzing the raw material consumption (RMC), for various countries and the European Union as a whole, Romania is placed midway on the chart, suggesting that its material footprint is neither at the high end nor the low end among the countries listed. Romania’s RMC is below the value for the entire European Union, indicating that Romania’s consumption induces less global material extraction than the EU average. Higher values on the chart imply greater demand for material extraction globally, which can be associated with higher environmental impact due to resource extraction processes. Romania’s value suggests a moderate level of induced global extraction. Understanding Romania’s RMC is essential for making policy decisions related to sustainable consumption and production, aiming to reduce the environmental impact of its material demand. The figure 2 provides a snapshot of Romania’s demand for global material resources, offering insight into the environmental impact of its consumption patterns and can help inform strategies for more sustainable resource use.

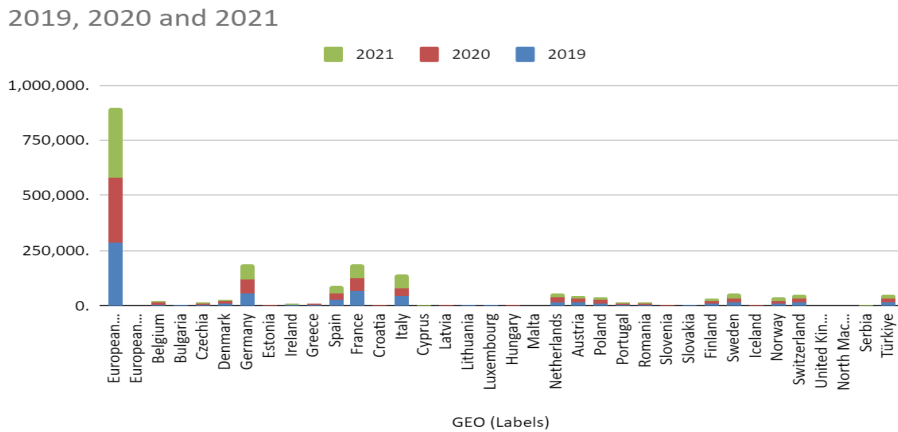
Figure 2. Raw material consumption in EU



Source: Eurostat, 2024

The data presented in Fig. 3 presents the gross value added (GVA) of the environmental goods and services sector (EGSS) in diverse EU countries, with a particular emphasis on its impact on the gross domestic product (GDP). The analysis of raw material consumption in the EU from 2019 to 2022 identifies notable discrepancies among member states. While the overall trend for the EU demonstrates stability, individual countries exhibit varying levels of consumption, reflecting differences in industrial activities and economic development. In comparison to the raw material consumption of individual member states, that of the EU is particularly high, this reflects the aggregate demand of all member countries. The overall trend appears to be relatively stable, with minor fluctuations between 2019 and 2022.

Figure 3. The gross value added (GVA) by the environmental goods and services sector (EGSS)



Source: Eurostat, 2024

The majority of countries, including major developed economies such as Germany, France, and the United Kingdom, demonstrate a stable pattern of raw material consumption from 2019 to 2022. This stability underscores the presence of well-established industrial practices and consistent economic activities. Countries with significant industrial bases, such as Germany, France, and the United Kingdom, naturally consume more raw materials, which highlights the correlation between industrial activity and raw material demand. Romania’s results are among the shorter ones on the chart, suggesting that the environmental goods and services sector contributes a smaller share of its GDP compared to many other countries listed. The European Union’s average GVA by EGSS is indicated on the chart. Romania is below this average, indicating that, proportionally, the country’s economy is less involved in producing environmental goods and services than the EU on average. Considering the relevance of SDG 12 Romania’s lower GVA by EGSS could suggest that there is potential for growth in sustainable consumption and production, as well as in building resilient and sustainable infrastructure. The chart provides an insight into where Romania stands in

the context of the European Green Deal and its alignment with the EU's sustainability priorities. Romania may have opportunities to expand its EGGS to contribute to sustainable industrialisation and innovation. For Romania, this data can inform policy-making to enhance investment in the EGGS, potentially leading to greater economic diversification and moving towards sustainable practices that align with EU priorities. The data suggests that Romania, while currently having a smaller EGSS contribution to GDP compared to other countries, may look towards policy and investment in this sector to drive sustainable economic growth and meet EU sustainability goals.

The overall trend across the majority of countries and the EU is an increase in gross value added (GVA) from 2019 through to 2021. This growth serves to underscore the expanding importance of the environmental sector, driven by heightened awareness, policy initiatives, and increased investments in sustainability. The sector's resilience, even during the challenging period of the Coronavirus Disease 2019 (Covid-19) pandemic, serves to highlight both its robustness and its potential as a future source of economic growth. In terms of individual countries, Germany, France and Italy are the principal contributors to the EGSS GVA. These countries demonstrate a persistent upward trajectory over the three-year period, indicating robust sectoral expansion. This growth can be attributed to the existence of substantial industrial bases, the implementation of comprehensive environmental policies, and the allocation of significant investments in sustainable technologies.

It is notable that countries such as Spain, the Netherlands and Sweden also make a moderate contribution to the GVA. Although their total GVA is less than that of the top contributors, they exhibit a similar upward trajectory, indicative of a gradual and consistent advancement within the sector. It seems probable that these countries will benefit from targeted policies and investments designed to strengthen their environmental sectors.

It is observed that countries with smaller economies or those with less developed environmental sectors, such as Malta, Luxembourg, and Cyprus, demonstrate relatively low GVA figures. Notwithstanding their comparatively minor contributions, these countries demonstrate growth from 2019 to 2021, indicating positive development. This suggests that even countries with smaller economies are recognising and investing in the potential of the EGGS. Some countries, such as Finland and Romania, exhibit slight fluctuations, with 2020 GVA values marginally higher than those in 2021. These anomalies could be due to specific economic conditions, policy changes, or external factors affecting the sector during those years.

Discussion

The study's findings shed important light on Romania's sustainable agricultural situation and how it relates to SDG 12. The examination of the rate of circular material usage, consumption of raw materials, and the GDP contribution of the environmental products and services industry reveals sectors that have made success as well as those

that still require work. Firstly, Romania's lower percentage of circular material use suggests that improved waste management programs and recycling incentives are required. To maximize material efficiency, policymakers ought to concentrate on advancing the circular economy and enhancing recycling infrastructure. Secondly, a balanced approach to material demand is suggested by Romania's low raw material usage. To lessen the negative effects of resource extraction on the environment, more sustainable methods and technologies must be used. Thirdly, the environmental products and services sector's comparatively small GDP contribution suggests that there is untapped development potential in sustainable businesses. Investing more in this area can promote sustainable growth and economic diversification.

A complex strategy including financial incentives, regulatory assistance, technology uptake, and stakeholder participation is needed to address these issues. The amalgamation of digital technology and data analytics offers auspicious prospects for enhancing resource allocation and refining agricultural decision-making procedures. Creating complete models that incorporate the social, environmental, and economic aspects of sustainability should be the main goal of future study. Tailoring solutions to local conditions and demands will also need investigating regional variances and improving sustainability indicators. Romania may join the international effort to balance economic activity with ecological preservation and social inclusion by promoting a culture of sustainable production and consumption. In order to provide a successful and long-lasting legacy for future generations, the nation's agriculture sector has the potential to become a beacon of development, emulating the transformational power of sustainable practices.

Conclusion

In the quest for sustainable development, Romania's journey through agricultural enhancement reflects both its rich potential and the challenges it faces in an ever-evolving global landscape. The insights gathered from a comprehensive analysis of the country's circular material use rate, raw material consumption, and contribution of the environmental goods and services sector to its GDP provide a valuable framework for understanding the intricate interplay of environmental responsibility and economic progress.

In its pursuit of economic growth and environmental stewardship, Romania has reached a pivotal crossroad where the implementation of strategic policies and investment in sustainable practices have become not just options but necessities for achieving long-term resilience. Guided by the European Green Deal and the Sustainable Development Goals, the country's future trajectory is becoming increasingly clear: aligning sustainability at the core of agricultural practices, promoting technological adoption and innovation, and integrating a circular economy that prioritizes resource conservation and minimizes waste.

The journey ahead for Romania is promising yet challenging, requiring concerted efforts from policymakers, stakeholders, and communities. It demands a transformative

approach to agriculture that prioritizes not only productivity but also the well-being of the environment and society. By fostering a culture of sustainable production and consumption, Romania can secure its place as a leading agrarian force within the European Union, contributing to a global movement that seeks to harmonize economic activity with ecological preservation and social inclusivity.

The article has outlined that although Romania's current performance in certain sustainable metrics may not be the most notable, the country presents a multitude of potential for growth. The lessons learned and the strategies outlined herein should serve as a catalyst for action, inspiring innovation, collaboration, and a steadfast commitment to a future where economic success and environmental stewardship are not mutually exclusive. As the world marches towards the 2030 Agenda for Sustainable Development, Romania's agricultural sector can serve as a model for progress, exemplifying the transformative power of sustainable practices to ensure a prosperous and enduring legacy for generations to come.

Conflict of interests

The authors declare no conflict of interest.

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